

Decontamination Strategies and Reusability of Chemical Protective Clothing

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Project Goals

- Develop suitable methods for chemical protective clothing (CPC) decontamination
- Develop evaluation methods for decontamination efficacy
- Develop guidelines for reusability of CPC
 - Decontamination and retirement

Stakeholders

- CPC Users & Manufacturers
- AIHA
- ISEA
- OSHA
- Emergency responders
- ASTM

Partnerships

- ICS® Inc. Laboratories, Brunswick, OH
- University of California, Davis, CA

Background:

- Nondisposable CPC is too expensive to discard, e.g., Level A Hazmat Suit > \$4,500; Viton Gloves > \$100
- Repeated use of CPC without effective decontamination may result in secondary exposure and injury
- Cost of illness due to skin exposure was estimated to be \$1 billion per year; more than \$800 million of protective gloves sold in the US annually
- OSHA requires decontamination of CPC under two regulations, i.e., 29 CFR 1910.120 and 29 CFR 1910.132

Methods

- Tests: ASTM F 739-99a and ASTM D 412-98a
- CPC Materials: include 7 most commonly used materials for suit and glove: natural rubber, nitrile, PVC, neoprene, Tychem, butyl, and Viton
- Chemicals: include 12 chemicals listed in ASTM F 1001
- Decontamination Methods for Comparison:
 - Heat Extraction: 100 °C for 16 hours
 - Water/detergent: Alcojet & an automatic dishwasher

- Self-decontamination: incorporate halamine functional groups in clothing material

Typical Results using Heat Extraction

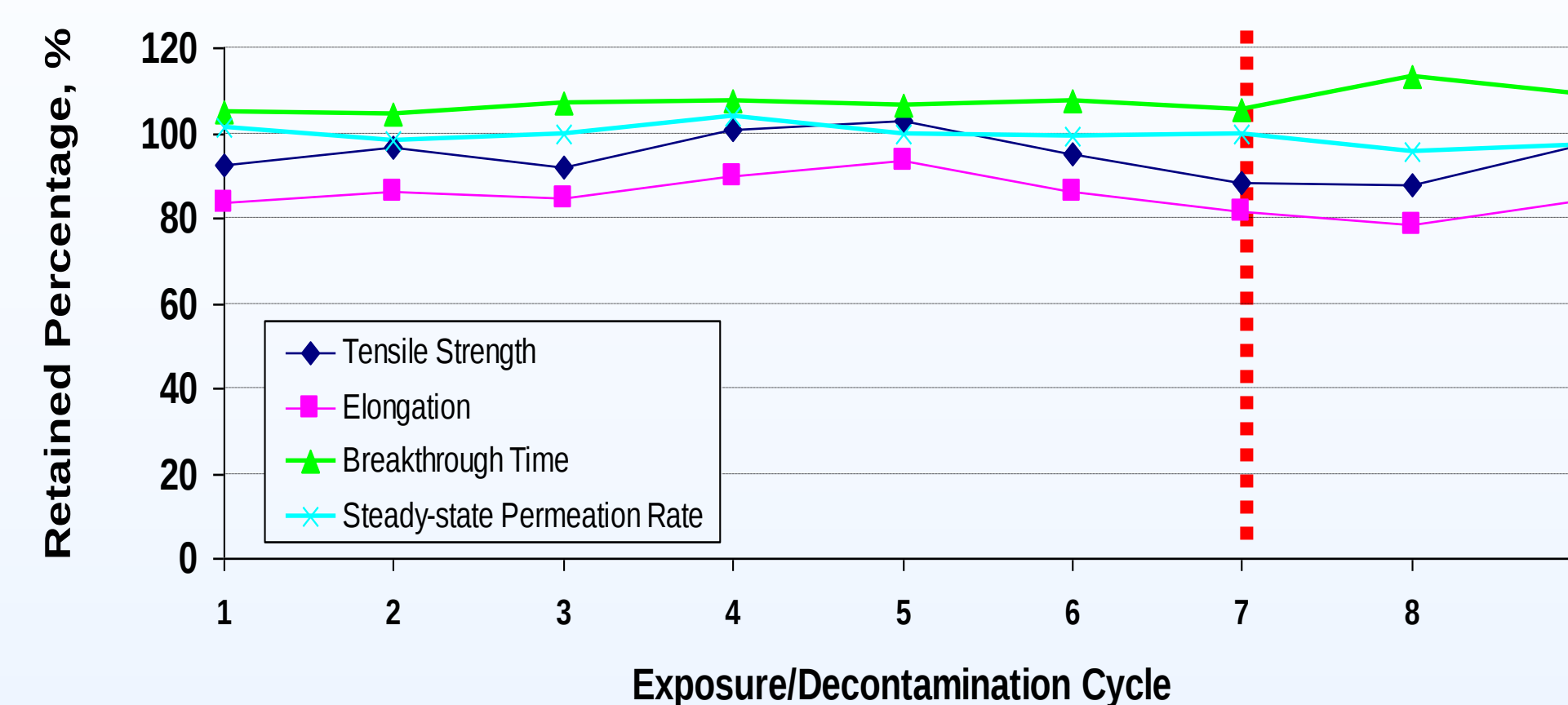


Fig 1. Reusability of nitrile gloves against acetone. After 7 exposure/heat extraction cycles, both chemical and physical properties retained $\geq 80\%$ in order to maintain the highest performance level (i.e., Level 4) based on ANSI/ISEA 105 standard.

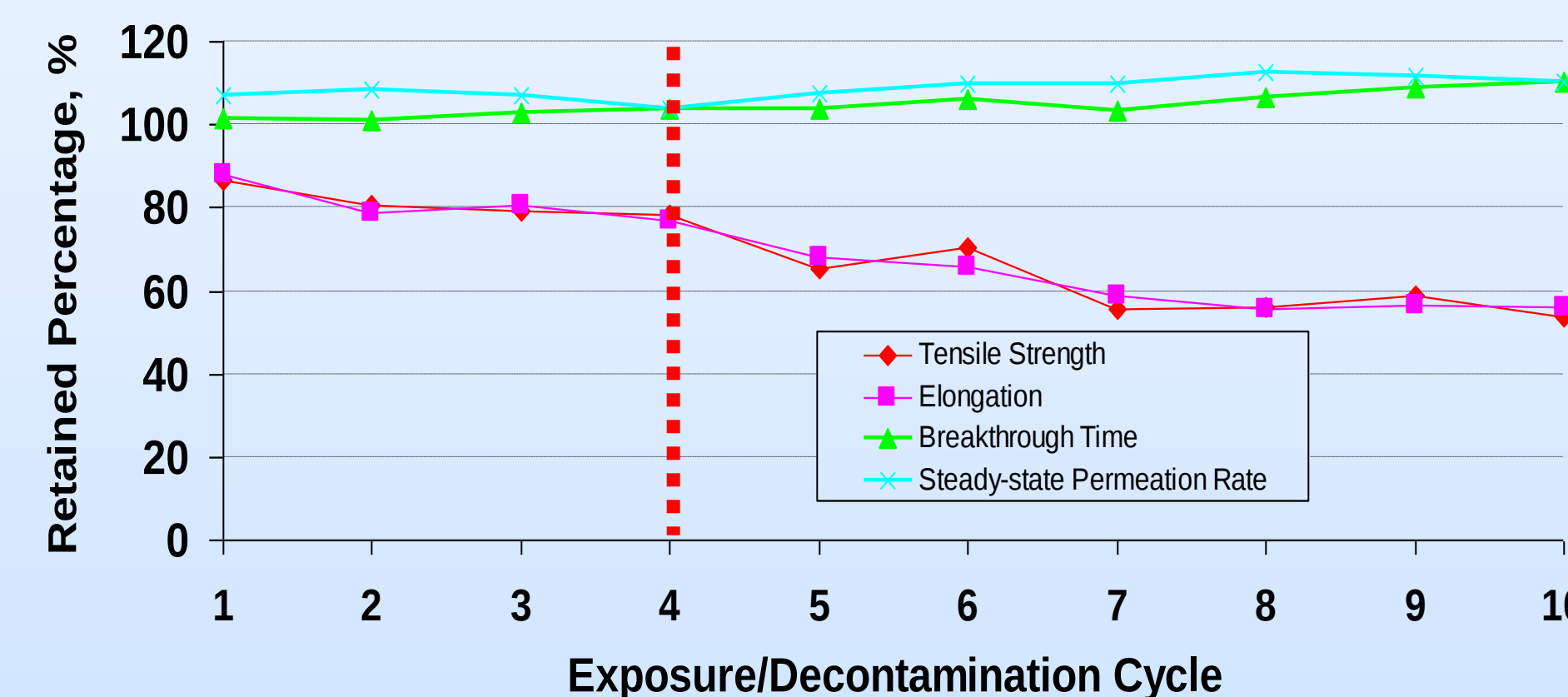


Fig 2. Reusability of neoprene gloves against acetone. Both chemical and physical properties retained $\geq 80\%$ after 4 exposure/heat extraction cycles.

Conclusions

- Some CPC materials can be re-used multiple times after decontamination with a minimal loss of protective properties.
- Thermal decontamination removed residual chemicals more effectively than water/detergent decontamination for most of the selected material-chemical combinations. However, less material degradation was observed for the decontamination using water/detergent.
- Halamine structures can detoxify some carbamates and toxic chemicals, and halamine grafted fabrics can be employed as self-decontaminating materials.
- In evaluating decontamination and CPC reusability, both chemical resistance and material degradation should be carefully investigated.

Outputs

- Software
 - Developed “Permeation Calculator” computer program for automated and standardized analysis of CPC permeation data. In 2008, the computer program received the NIOSH Bullard-Sherwood Research-to-Practice (r2p) Technology Award and the CDC Director's Innovation Award.
- Journal Publications
 - Gao, P, El-Ayouby N, and Wassell JT[2005]. Change in permeation parameters and the decontamination efficacy of three chemical protective gloves after repeated exposures to solvents and thermal decontaminations. *American Journal of Industrial Medicine*, 47(2):131-143.
 - Gao, P and Tomasovic B [2005]. Degradation of neoprene and nitrile chemical protective gloves after repeated acetone exposures and thermal decontaminations. *Journal of Occupational & Environmental Hygiene*, 2(11): 543-552.
 - Xin F, Gao P, Shibamoto T, Sun G [2006]. Pesticide detoxifying functions of N-halamine fabrics. *Archives of Environmental Contamination and Toxicology*, 51: 509-514.
 - Gao, P, Weise T, and Tomasovic B [2009]. Development of a computer program for permeation testing data analysis. *Journal of Occupational & Environmental Hygiene*, 6: 363-373

Outcomes

- AIHA Protective Clothing & Equipment Committee guideline on CPC and equipment decontamination.
- ASTM F23 work item titled “Standard practice for permeation testing data analysis by use of a computer program”.

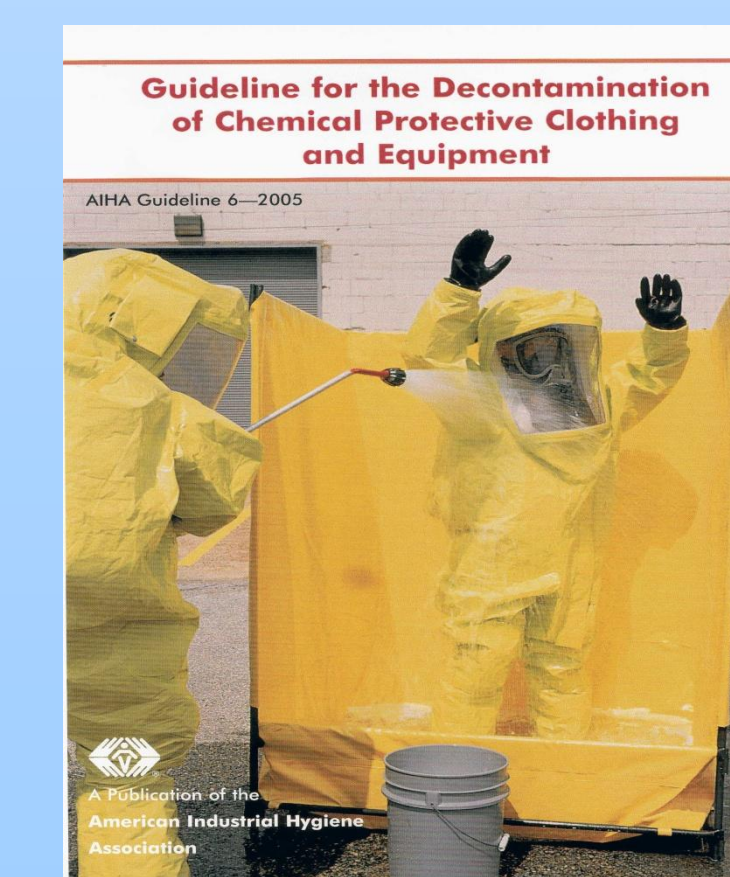


Fig 3. AIHA guideline for CPC and equipment decontamination



Fig 4. Permeation Calculator v2.4.1
<http://www.cdc.gov/niosh/npptl/PermeationCalculator/permeationcalc.html>

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